(12) UK Patent Application (19) GB (11) 2 327 020 (13) A

(43) Date of A Publication 06.01.1999

(21) Application No 9713802.8

(22) Date of Filing 30.06.1997

(71) Applicant(s)
Telefonaktiebolaget L M Ericsson
(Incorporated in Sweden)
S-126 25, Stockholm, Sweden

(72) Inventor(s)
Claus Popp Larsen

(74) Agent and/or Address for Service
Haseltine Lake & Co
Imperial House, 15-19 Kingsway, LONDON,
WC2B 6UD, United Kingdom

(51) INT CL^6
H04L 12/437 , H04B 10/213 , H04J 3/08

(52) UK CL (Edition Q)
H4P PPD
H4B BK20T BK8

(56) Documents Cited
GB 2286745 A **GB 2282301 A** **GB 2173977 A**
GB 2148671 A **EP 0212806 A2** **WO 97/13291 A**
WO 97/01907 A1 **WO 92/04787 A1** **US 5495472 A**

(58) Field of Search
UK CL (Edition P) **H4B BKR BK20 BK20T BK20T1 BK20T2 BK20T2B BK8 BK8B BN , H4P PEE PEUL PPD**
INT CL^6 **H04B 10/00 10/08 10/20 10/213 , H04J 3/08 H04L 1/22 12/437 , H04Q 11/00**
Online : WPI

(54) Abstract Title
A self-healing meshed network

(57) A self-healing meshed network includes protection rings in the form of a series of closed loops 42,44. Each node-to-node link 32,34 in the network is protected by a counter-propagating link 46,48 which forms a part of one of the closed loops. Each closed loop preferably passes through three or four of the network nodes 36,38,50. In the event of a cable break, traffic intended for the broken link can instead be routed into the protection ring at the head node, and routed back into the network at the tail node for onward transmission.

The network is electrical, using twisted pairs or coaxial cable, or optical. Links can be uni-directional or bidirectional.

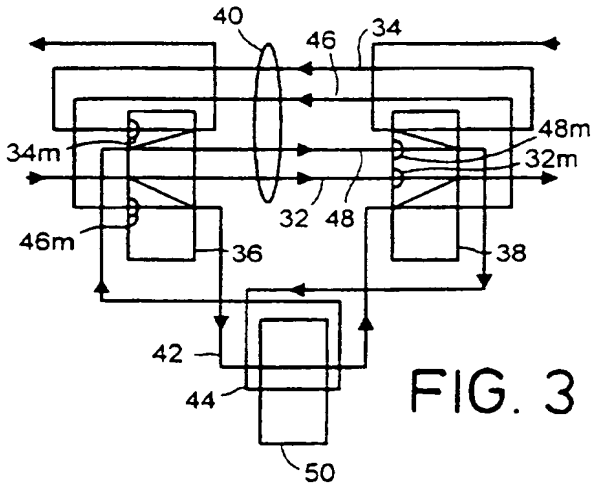


FIG. 3

GB 2 327 020 A

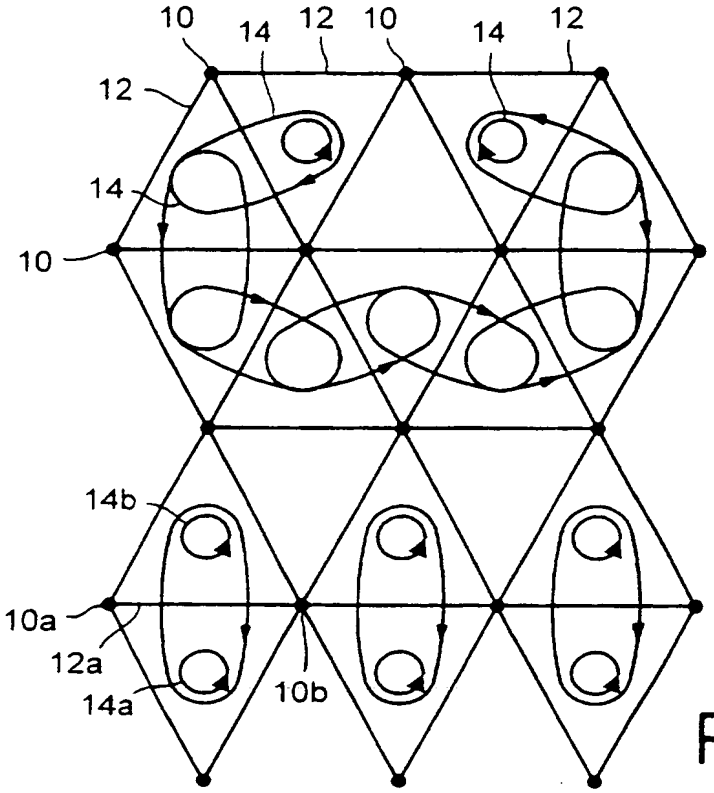


FIG. 1

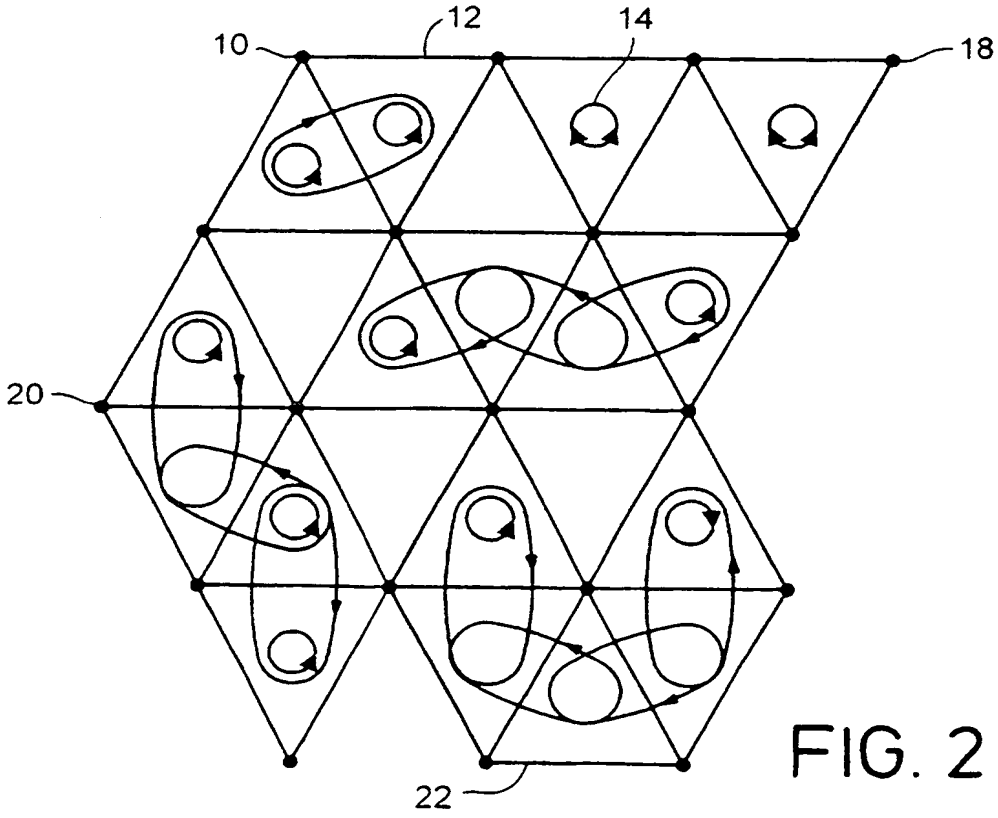


FIG. 2

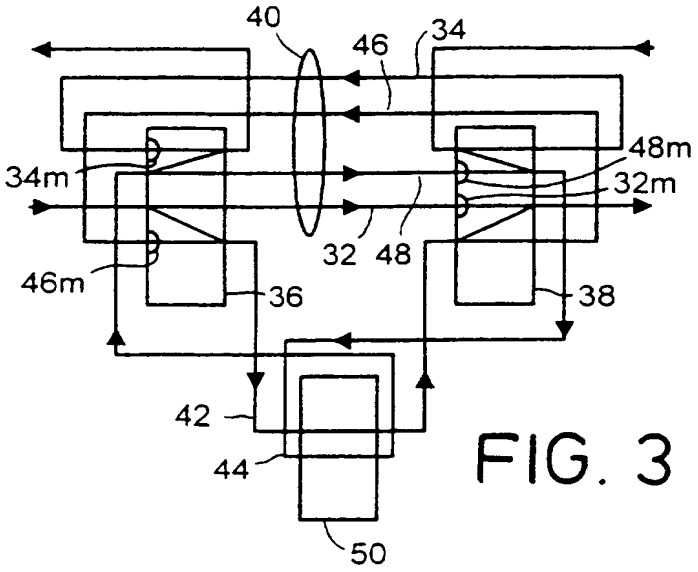
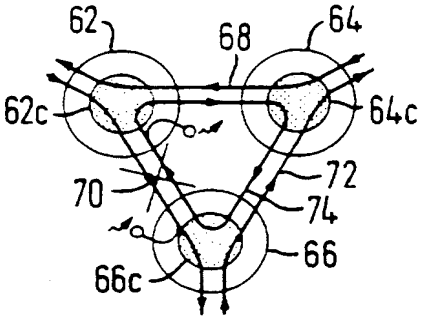


FIG. 3

FIG. 4(a)



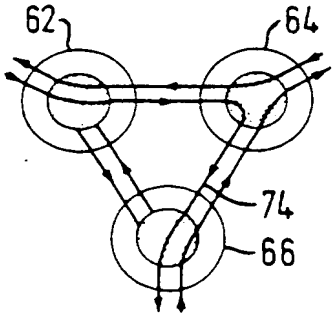
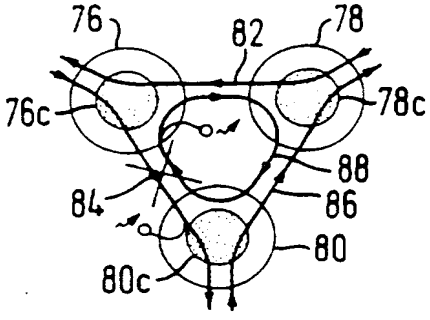


FIG. 4(b)

FIG. 4(c)



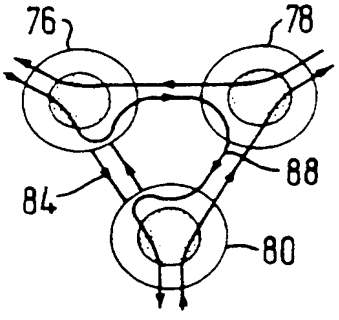


FIG. 4(d)

2327020

NETWORK

TECHNICAL FIELD

This invention relates to a network, for example an electrical or optical network, for use in telecommunications or data communications. More specifically, the invention relates to a self-healing meshed network.

DESCRIPTION OF RELATED ART

In telecommunications and other networks, the ability to provide automatic protection switching or restoration, in the case of a cable break, is a desirable if not an essential feature.

In a ring network, that is one in which all the nodes lie on a single ring, protection switching systems are known which are "self-healing". An example of such a system is disclosed in WO97/01907. In a true self-healing system, the system is able to perform traffic restoration without communicating with a central management system. This has the advantage that restoration can be quick.

Restoration in a ring network is relatively easy, but it is more complicated in a meshed network, that is, a network in which there may be several possible paths between any two nodes in the network. One possibility is to let the network management system investigate and calculate where in the network there is additional capacity to handle the traffic which would otherwise be carried on a broken link between two nodes. However, this use of system management resources can be time-consuming.

WO92/04787 discloses a meshed network, in which the network is configured as a set of logical hybrid rings. Each logical ring is formed from a cascade of (i) physical connection paths interposed with add-drop multiplexer nodes and (ii) cross-connect nodes. To reconfigure the logical rings, a management node

communicates with the cross-connect nodes and can issue reconfiguration commands. This structure has the disadvantage that it requires signalling between nodes in the event of a failure, and that a signal, particularly in the protection paths, may need to pass through many more nodes than in a meshed network.

SUMMARY OF THE INVENTION

The present invention seeks to provide a self-healing meshed network which, in preferred embodiments, allows quick restoration with no need for signalling between nodes, with no need for communication with the management system until after the restoration has been performed, and without requiring large amounts of additional equipment to achieve implementation in existing networks.

According to the present invention, the network is made up of a plurality of physical links, and each physical link is protected by a link in a logical protection ring, each logical protection ring being in the form of a closed loop.

Put another way, each node-to-node link in each direction is protected by a counter-propagating link which forms part of a respective closed protection ring.

Each node includes a device for detecting a cable break and a device for re-routing signals intended for the broken link onto the protection ring.

This arrangement has the advantages that restoration can be achieved quickly, without involving the network management system. Moreover, the system is easy to implement in existing networks.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic representation of a network in accordance with the invention.

Figure 2 is a schematic representation of the network of Figure 1, with modifications in accordance

with the invention.

Figure 3 is a schematic representation of the connections between three nodes forming part of a network in accordance with the invention.

Figures 4(a)-4(d) illustrate the operation of a network in accordance with the invention, in the event of a cable break.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 shows a network, made up of a number of nodes 10, connected by a number of bidirectional node-to-node links 12. It will be appreciated that a real network will rarely be so regular, but this representation is sufficient to illustrate the principle of the present invention.

In accordance with the invention, the network also includes a number of closed loops 14, such that each node-to-node link 12 is protected by parts of two counter-propagating protection rings.

The principle of the present invention is that, in the event of a cable break at any point in the system, traffic intended for that link can instead be routed between the two nodes affected around the relevant protection ring. The reason for using a series of closed loops for the protection rings is that this allows the protection fibre to be shared, without requiring signalling between the nodes.

For example, if the link 12a between nodes 10a and 10b is broken, traffic from node 10a to node 10b can be routed around protection ring 14a, and traffic from node 10b to node 10a can be routed around protection ring 14b.

Thus, a bi-directional node-to-node link needs to be protected by parts of two respective protection rings, but a uni-directional node-to-node link needs to be protected by a part of only one counter-propagating protection ring.

It will be noted that, in the example of Figure 1, all of the protection rings cover only three or four nodes. This is because it is advantageous to make each ring as small as possible (in terms of the number of nodes it covers at least, the physical size of the ring is less relevant). Specifically, reducing the size of the rings makes it easier to plan the rings, and hence makes it easier to add extra nodes when required, as well as reducing the extra distance travelled by signals when the protection ring is in service.

Figure 2 shows a modification of the network of Figure 1, which further includes two additional nodes 18, 20, connected to the original network by respective bi-directional node-to-node links and one additional node-to-node link 22. It will be noted that some of the protection rings used in the example shown in Figure 1 have needed to be changed in the example shown in Figure 2, although this is a relatively minor inconvenience.

Figure 3 shows in more detail the structure of a protection link. Two counter-propagating traffic fibres 32, 34 pass between two nodes 36, 38 along a four fibre link 40. Thus, along the link 40, fibre 32 carries signals from node 36 to node 38, while fibre 34 carries signals from node 38 to node 36. This link is protected by two counter-propagating closed loops 42, 44, which have respective fibres 46, 48 passing between nodes 36 and 38, and also pass a third node 50.

Each fibre 32, 34, 46, 48 has a respective monitor 32m, 34m, 46m, 48m located at the input to the respective one of the nodes 36, 38.

In the event of a cable break between nodes 36 and 38, the monitors 32m, 34m, 46m, 48m sense the loss of the signal and automatic switching is carried out. Either the absence of a signal in the traffic fibre at the tail node, or the absence of amplifier noise or an

idle probe signal in the protection fibre at the head node, can be used to detect the cable break. Of course, the same principle can be applied if the signal quality measured at the monitors falls below a threshold. Thus, traffic on fibre 32 is switched to loop 42, and traffic on fibre 34 is switched to loop 44. The head node switches the traffic into the protection ring, and the tail node switches the traffic received on the protection ring back into the main fibre. Of course, in the case of a bi-directional link, each node acts as both a head node and a tail node.

After the protection switching has been carried out, the management system is informed, as the nodes send messages.

It will be apparent from the foregoing description that all node-to-node equipment, for example fibre and amplifiers, must be doubled, but this is not thought to be a serious disadvantage. In the case of the cable itself, for example, there is usually a requirement for extra fibre whatever protection system is used, and the necessary fibre is often already in position, ready for use.

Figure 4 shows in more detail two ways in which the switching can be carried out in the nodes, in the event of a cable break. The illustrated nodes form part of a meshed network. Thus, they can each handle several incoming fibres. Figure 4(a) shows an arrangement with three nodes 62, 64, 66, with respective cross-connects 62c, 64c, 66c. Respective uni-directional links 68, 70, 72 connect the three nodes, and are protected by a protection ring 74 in the form of a closed loop. It can be seen that the protection ring traverses the cross-connects 62c, 64c, 66c in the nodes. This has the effect that all node equipment is doubled, which may be advantageous in its

own right.

Figure 4(b) shows the situation in which link 70 is broken, and traffic from node 62 to node 66 is routed onto the protection ring 74 via node 64.

In the arrangement of Figure 4(c), three nodes 76, 78, 80 have respective cross-connects 76c, 78c, 80c. Respective uni-directional links 82, 84, 86 connect the three nodes, and are protected by a protection ring 88 in the form of a closed loop. It can be seen that, in this case, the protection ring does not traverse the cross-connects 76c, 78c, 80c in the nodes. In this case, each node includes an additional 2x2 switch, which folds the traffic into and out of the protection ring.

Figure 4(d) shows the situation in which link 84 is broken, and traffic from node 76 to node 80 is routed onto the protection ring 88 via node 78.

The network of the present invention can be electrical, using twisted pairs of wires or coaxial cable, or optical. However, the arrangement of Figures 4(c) and 4(d) is most relevant to optical networks. In an optical network, the restoration is potentially independent of the signal bit rate, format or protocol. Different signals can in principle be routed onto the same protection ring, having arrived on different fibres.

There is thus described a method of adapting an existing meshed network so that is becomes self-healing, without requiring excessive additional equipment, and without placing an additional signalling load on the network management system.

CLAIMS

1. A network, comprising a plurality of physical links, wherein each physical link is protected by a counter-propagating link in a logical protection ring, each logical protection ring being in the form of a closed loop.

2. A network as claimed in claim 1, wherein each unidirectional link is protected by a counter-propagating link in a logical protection ring.

3. A network as claimed in claim 1, wherein each bidirectional link is protected by a pair of counter-propagating links in respective different logical protection rings.

4. A network as claimed in claim 1, wherein each node includes a device for detecting a cable break and for re-routing signals intended for the broken link onto the protection ring.

5. A network as claimed in claim 4, wherein each device for detecting a cable break comprises means for detecting an absence of a signal.

6. A network as claimed in claim 4, wherein each device for detecting a cable break comprises means for detecting that measured signal quality has fallen below a threshold.

7. A node for a meshed network, comprising means for detecting a cable break and means for re-routing signals intended for a broken link onto a protection ring in the form of a closed loop.

The Patent Office

8

Application No: GB 9713802.8
Claims searched: 1-6

Examiner: Keith Williams
Date of search: 25 September 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4B (BK8, BK8B, BKR, BN, BK20T, BK20T1, BK20T2, BK20T2B; H4P (PEE, PEUL, PPD)

Int Cl (Ed.6): H04B 10/00, 10/08, 10/20, 10/213; H04J 3/08; H04L 1/22, 12/437

Other: Online WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2286745 A	GPT Limited - see Fig. 2 and abstract (and WO 95/22860 A1)	1
X	GB 2173977 A	STC plc - see Fig. 1 and abstract	1
A	GB 2148671 A	GEC - see page 6, lines 89 onwards (and WO 85/01850 A1)	
X	EP 0212806 A2	Northern Telecom - see Fig. 1 and Claim 1 (and US 4736465)	1
X	WO 97/01907 A1	Telefon. Ericsson - see abstract	1
A	WO 92/04787 A1	Bell Comms. - see abstract (and US 5327427)	

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

9

Application No: GB 9713802.8 **Examiner:** Keith Williams
Claims searched: 7 **Date of search:** 31 March 1998

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): H4B (BK8, BK8B, BKR, BN, BK20, BK20T, BK20T1, BK20T2, BK20T2B); H4P (PEE, PEUL, PPD)

Int Cl (Ed.6): H04B 10/00, 10/08, 10/20, 10/213; H04J 3/08; H04L 1/22, 12/43 H04Q 11/00

Other: Online WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2286745 A	GPT - see page 5, lines 4-6; page 11, lines 8-9; Figs.2,7 (and WO95/22860)	7
A	GB 2282301 A	Fujitsu - see abstract	7
X	EP 0212806 A2	Northern Telecom - see page 4, lines 10-21	7
X	WO 97/13291 A1	Robert Bosch GmbH - see abstract	7
A	WO 97/01907 A1	Telefon. Ericsson - see abstract	7
X	WO 92/04787 A1	Bell Comms. - see whole specification (and US 5327427)	7
X	US 5495472	Fujitsu - see Fig. 3	7

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family
A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.